

Films and Compound Films with an Embossed Pattern, Particularly for
Producing Electrochemical Components

5 The present invention relates to a spatial configuration of films with electrochemical properties, wherein the films can be used for producing layer compounds for use as batteries, electrochromic compounds or the like.

10 Since the beginning of the '70s, it has been attempted to produce electrochemical components such as batteries or the like in the form of thin films. The object is to obtain components that, on the one hand, are so flexible that they can be, for example, rolled up or matched to another desired shape and, on the other hand, can provide particularly beneficial charging and discharging properties by means of extremely large contact surfaces between the individual electrochemical parts, such as electrodes or electrolytes, relative to the employed volume of electrochemically active material.

15 The film technology fulfills the aforementioned requirements in an excellent way. Therefore, electrode materials or electrolyte materials in film form, for example, for batteries, are produced as fabricated material that are subsequently combined to a film compound with the desired electrochemical properties by lamination under suitable pressure action or temperature action. Examples for the manufacture of such films are known in many embodiments in the patent literature or in the relevant technical literature and are known to a person skilled in the art.

25 The manufacture of electrochemical components by means of (endless) films provides great economical advantages because film processing at high speed can be performed. In this connection, an advancing speed of several meters per minute is possible. However, for such a manufacture several boundary conditions must be observed that require a high technical expenditure. This is based in particular on the fact that, for obtaining a high throughput, the different films must be processed

as long as possible from roll to roll or in the form of large sheets in order to reduce the number of manipulation steps. If it is desired to separate the complete stacked/laminated film compounds after their processing, it is necessary to perform stamping actions through the complete film compound. However, this results in significant problems because the separation by cutting tools generates edges of cut through the complete film compound. In this connection, the cutting tool can cause smearing of materials from different films across the edges of cut; this has negative effects with regard to the functionality of the electrochemical components. Separation of the different films already before lamination however requires a precise arrangement of the film elements relative to one another before they are laminated or connected in other ways. However, this can be realized only with great difficulty in particular for a high manufacturing throughput.

It is an object of the present invention to prevent the above described smearing of material across the edges of laminated film compounds wherein the method at the same time should enable the manufacture of laminated individual elements at high speed. In particular, this object is directed to such film compounds that are to be used in or as electrochemical components.

This object is solved by providing films with a specific stamped pattern similar to a perforation; the stamped pattern predetermines the edges of cut for the future separation - by cutting or another method - of compounds from such films that are laminated to one another or joined otherwise. In this connection, the stamping defines at least one, generally several, dividing lines that can be arranged, for example, at a right angle to one another and are interrupted by webs in a regular pattern. These webs have a width that is, on average, less than the average spacing between two webs. In particular, it is preferred that the width of each web is less than the spacing of this web to the neighboring webs. Also, it is optionally preferred and in some cases necessary (for example, when three films according to the invention are provided for a film compound) that the width of the webs, on

average, is not more than half the average spacing between two webs.

The films according to the invention enable, on the one hand, processing of the respective films from roll to roll or in the form of large sheets, and, on the other hand, they can be stacked on top one another such that their dividing lines for the future cutting step or the like are superimposed while the webs of these dividing lines are staggered relative to one another so that they are never superimposed. Therefore, during the subsequent separation there is nowhere an edge of cut with smearing of the components of the individual films of the film compound so that contact between the materials of the different films cannot occur.

In a preferred embodiment of the invention, the stamping defines at least in one direction (y) dividing lines that extend parallel to one another and are arranged such on the film sheet or film leaf (positioned in the x-y plane) or the film roll that the webs, when mirrored at the center of the film perpendicularly to these dividing lines (i.e., mirrored at a centrally arranged plane in the x-z direction), will not be superimposed on the webs of the film that is not mirrored. When two such films are laminated with one another with one film being positioned mirror-inverted relative to the so-called x-z plane relative to the other film, the webs of the dividing lines in the y direction cannot overlap, which is desired.

In a preferred second embodiment, the stamping defines dividing lines that extend perpendicularly to one another. The webs of one or several dividing lines extending in a first direction (x) are arranged such that, when mirroring at a mirror plane (y-z) that intersects the film centrally and perpendicularly to said first direction, they will not be superimposed on the webs of the film that has not been mirrored. When two such films are laminated to one another while the head (viewed in the x direction) of one film is positioned above the foot (viewed in the same direction) of the other film, the webs of the dividing lines in the x direction cannot overlap, which is desired.

It is particularly preferred to combine the features of the two above described embodiments with one another, in particular, in such a way that a stamping pattern with at least one dividing line in the x direction and several dividing lines in the y direction is produced whose webs - those of the dividing line(s) in the x direction as well as those of the dividing lines in the y direction - upon rotation about a central axis z that extends perpendicularly to the film plane (x-y) will not be superimposed. In this configuration, both films of a future laminate can be provided with precisely the same stamping pattern, i.e., can be produced with the same machines without having to change their adjustments, and be can arranged for forming the film compound such on top one another that the first film is superimposed on the second film by being turned over and rotated by 180°. In this spatial position relative to one another, the webs of the two films cannot overlap.

Alternatively, it can also be expedient to generate the stamping pattern with other patterns such that the stamping pattern of the first film to be laminated cannot be brought into a congruent arrangement with the second film to be laminated. Such asymmetries can help to reduce the risk of possibly erroneous stacked arrangement when stacking the films on top one another.

When the films according to the invention are provided as a cathode film or anode film, they are generally already laminated with preferably a net-like discharge film whose current dischargers project past the lateral edges of the film. Film compounds with such films will be separated only in such a way that in the (shorter) transverse direction not more than two components, whose dischargers project laterally from the film, are provided adjacent to one another on the basic surface of the film compound. In other words, such films will have no, or at most one, dividing line on the (longer) x axis. When in these configurations having a central dividing line the current dischargers are kept sufficiently narrow and are arranged asymmetrical to one another relative to the side from which they project, but are arranged symmetrical to one another relative to the left and to the right, the films as

described in connection with the second preferred embodiment as well as in connection with the embodiment described as being especially preferred can be superimposed without there being the possibility that the current dischargers of cathode and anode could contact one another.

5 In order to simplify the exact positioning of the individual films relative to one another during stacking it can be advantageous to provide holes for positioning pins simultaneously with the film stamping step for producing the future cutting lines. Such positioning openings can be provided in the center of each element but also at other locations of the film, for example, in the webs of the stamped dividing line.

10 The manufacture of the stamped films is realized in stamping tools as they are known in the prior art. Preferred is a method in which a holding-down device presses the film to be stamped fixedly against a support. Subsequently, a hollow-ground blade is moved downwardly through a slot in the holding-down device. This blade carries out the cut and forces the material that has been separated in the
15 downward direction so that it is removed from the web area.

In Fig. 1, an example of a film according to the invention is illustrated. These films, for example, are suitable for manufacturing film-based batteries that are comprised of three films: the anode A, the cathode B, and the separator. The separator separates anode and cathode electronically and can therefore be placed without
20 being pre-stamped between the two electrode films. The correlated current dischargers 1, 2 project from the electrode films, respectively; they are indicated by cross-hatching. When the stamped film B is placed onto the stamped film A, the arrangement as shown in C results. As a separation means between the anode A and the cathode B the separator is introduced. The separator must not be pre-stamped and is therefore not illustrated in the drawings of Fig. 1. Along the dividing
25 lines 3 in the x direction and 4 in the y direction, illustrated in dashed lines, individual elements can be separated from the film compound C by a cutting tool in

such a way that the cutting blade does not cut at any location through all films at the same time but cuts only through the webs, respectively, of the individual films that are staggered relative to one another. The stamping of the films illustrated in Fig. 1 is a concrete example for the above embodiment that has been mentioned as particularly preferred in which the stamping pattern of the films A and B is symmetrical in such a way that both films can be pre-stamped by the same stamping tool and the pattern of the film B is transferred by a simple rotational mirroring into the pattern of the film A.

In Fig. 1, additional openings for positioning pins are provided which are referenced by reference numeral 5. The position of the positioning openings in this embodiment is at the center of each field that predetermines the dimensions of the future component.